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OIL-CAMP SANITATION

BY

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OIL-CAMP SANITATION.

By C. P. Bowie.

INTRODUCTION.

Although Federal and State bureaus and individuals have written much on sanitation in rural districts in the United States, the author has repeatedly observed, during visits to mining camps, oil fields (especially those of the "boom" variety), fruit districts during the harvest season, and other places of temporary or semitemporary habitation, that the advice given by these writers is for the most part disregarded, and that much remains to be done in an educational way before the plane of sanitation in such districts becomes relatively as high as that in cities.

A trip through the oil fields of the United States, particularly those in Texas and Oklahoma that are passing through the "boom," impressed on the author the necessity of more and constant work on the part of Federal and State bureaus to the end that the deplorable living conditions in some of these districts may be improved.

In the older oil fields, as those of Pennsylvania, West Virginia, Ohio, and Illinois, the sanitary conditions about oil wells are practically the same as the sanitary conditions of the surrounding country. The oil workers usually live at the farm houses in the vicinity, and as production in the oil fields becomes settled, the pumping of the wells is carried on by farm laborers or by men who live in the neighboring towns. Sanitary conditions in these districts are seldom all that can be desired; they are, however, much superior to conditions in the oil fields of less populated districts such as Oklahoma, Texas, and Louisiana.

Many oil men, especially those operating in districts east of the Rocky Mountains, employ the contract system of drilling, which almost eliminates the tendency of companies to build camps or small towns over which they may exercise personal supervision as to housing and sanitation. In the contract system, the company bargains for the development of its holdings with a contractor who provides, at a stipulated price, the material and labor for drilling the wells. The system relieves the company of all responsibility except its financial obligations to the contractor.

The contractor engages his drillers, tool dressers, and laborers. Most of them are brought from outside districts, and if oil is found

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and the field gives promise of commercial production, the oil workers are followed by freighters, "jitney" drivers, restaurant keepers, innkeepers, and the innumerable small-trades people who, with their families, go to make up the population of such districts. So it is that a stretch of trackless prairie sometimes becomes, almost overnight, a community numbering thousands of people who establish themselves in temporary buildings, tents, dugouts, lean-to shelters, or even within four topless walls of burlap, or in the open. These mushroom communities have been aptly termed "rag towns."

SANITARY CONDITIONS IN "BOOM" COMMUNITIES.

Ranger, Desdemona, and Burk-Burnett were towns of this type in 1919. They had either no water supply, or a wholly inadequate one; garbage, decaying vegetable matter, tin cans, old rags, and paper laid in small heaps about temporary structures or were strewn promiscuously over vacant lots. Privies had been built, some from new lumber with rain-proof sides and roofs, hinged doors, and battens over the cracks. Many, however, were makeshifts, built of old boards on end, tepee fashion, or of sacking hung on a frame about an improvised seat over a shallow hole without effort to screen out the flies or to afford protection from vermin. Practically all of these structures, those especially built for the purpose as well as the improvised, swarmed with flies, reeked with filth, and gave off such odors that the populace refused to use them. The result was that the ground for acres about was defiled.

It was argued that, while these facts were deplorable, they were the results of extraneous circumstances and would be remedied as soon as conditions returned to normal. But experience has shown that so-called "normal" conditions are never attained until such a community has been visited by costly fires and epidemics. In fact, "normal" conditions are not established until the field has been proved a success or a failure, which often takes months or even years.

BETTERMENT OF CONDITIONS.

The responsibility for the betterment of such conditions plainly belongs to the State governments; broadly speaking, all the States have legislation adequate to cope with these exigencies. The enforcement of the laws, however, too often is left to the community itself and rests in the hands of a few men who, because of political aspirations, can not afford to run the risk of antagonizing their neighbors by the enforcement of ordinances, or who are so engrossed in business that they are indifferent to the responsibilities entrusted to them. Therefore, refusal or neglect to meet the social responsibilities that accompany the hiring of human beings for labor brings hardship and unnecessary misery to a class unable or indisposed to

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combat the personal indignities that make for degradation and crime, and that increase the social unrest of uncared-for migratory workers the world over.

The employer is also a sufferer. He meets a material loss through the "soldiering" of discontented workers, petty strikes, and an enormous turnover in his force of laborers. The Federal Bureau of Mines addresses this pamphlet particularly to the oil operator who through his daring enterprise is adding to the wealth and prosperity of the Nation, as, after all, it is through his leadership that human beings congregate in the oil fields, and with that leadership, morally at least, goes also a measure of responsibility for the lives and happiness of his fellow beings. He can do much to increase their welfare and at the same time bring greater prosperity to himself.

Experience [1] has shown that insanitary conditions may decrease the working efficiency of the men 25 per cent. In a camp of 50 men with an average daily wage of $5, a 25 per cent loss in efficiency would mean a daily loss of $62.50, or $1,875 per month. One roustabout at $4 a day could keep the camp clean after it was once put in good condition; and an additional expenditure of $6 a day should provide necessary teams, extra labor, and repairs, so that $300 per month would cover the cost of good sanitation; the actual saving would be $1,575 per month, or $18,900 a year. From the first year's saving it would be necessary, of course, to deduct the initial cost of the sanitary installations; for a camp of 50 men this expense should not exceed $3,000.

ACKNOWLEDGMENTS.

The author wishes particularly to acknowledge the valuable assistance of Charles Gilman Hyde, professor of sanitary engineering of the University of California, in the preparation of this report. Thanks are also due for material and kindly criticism to Wilfred F. Langelier, associate professor of civil engineering of the University of California; A. J. Lanza, M. D., and J. B. Newman, of the United States Public Health Service; G. B. Maloney, chief engineer of the Associated Pipe Line Co.; Henry D. Dewell, consulting engineer, San Francisco, Calif.; and to J. O. Lewis, former chief petroleum technologist, T. T. Read, F. B. Tough, E. W. Wagy, R. E. Collom, and Miss H. M. Lansche, of the Bureau of Mines.

FLIES.

Flies, the greatest of all disease carriers, breed in manure piles, kitchen refuse, garbage, and human excrement. Often they are directly responsible for the spread of such diseases as typhoid, dysentery, diarrhea, and other intestinal disorders. They may also carry

[1] Advisory pamphlet on camp sanitation and housing: Commission of Immigration and Housing of California. 4th ed., November, 1915, p. 7.

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the infections of pink eye, anthrax, glanders, and erysipelas. Flies carry germs on their feet and bodies, and in their bodies, from the excrement of some one affected with disease to the food consumed by those in the camp. By disposing of their breeding places a community disposes of the flies, thereby eliminating one of the main causes of much sickness. All that is necessary is prompt and proper disposal of manure, garbage, and sewage, as described on the pages following.

Ninety-eight per cent of the flies around human habitations are the common house flies, *Musca domestica*. The female begins depositing eggs from 9 to 12 days after emerging from the pupa case; she deposits 75 to 150 eggs singly in masses, and two to four such layings occur at intervals of four to five days. Usually horse manure is the material upon which the eggs are laid and upon which the larvæ feed. However, flies lay eggs in garbage, kitchen refuse, human excreta, and even on ground that has been soiled by manure or garbage.

The eggs hatch in 12 to 24 hours; the larvæ begin feeding at once and grow rapidly. The larva, or maggot, stage lasts four to six days; then the maggots leave the material upon which they feed and burrow into the ground beneath it. Here they pupate, and the transformation into the adult fly takes place, this change requiring six to eight days. The time from the laying of the egg to the formation of the adult fly is, therefore, usually 10 to 14 days.

During the summer weather, under ordinary conditions, flies live 30 to 60 days. Some hibernate. and if they find proper protection, live through the winter.

Throwing fresh earth on ground infested with maggots seldom destroys them, as the adult fly can emerge through 6 feet of earth. Burning over the surface is ineffective because the maggots burrow too deep to be destroyed by the heat. According to Vedder [2] they can be killed by sprinkling the surface of the ground with solutions of borax or powdered hellebore. Two-thirds of a pound of borax should be used to 10 gallons of water, or one-half pound of powdered hellebore to 10 gallons of water.

FLYTRAPS.

Even by these measures the flies may not be eliminated, as they sometimes travel far and may arrive from some relatively remote section where their breeding places are allowed to remain undisturbed. Such precautions will, however, greatly reduce their number.

Most of those coming from a distance may be caught in properly constructed traps. If the premises are kept clean, the traps will be very effective, as they offer the only feeding places. In form 45–C of the Department of Health, Commonwealth of Pennsylvania, the

[2] Vedder, E. B., Sanitation for medical officers; 1st ed., Philadelphia, 1917, p. 111.

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author describes, as follows, an effective trap which he has seen in use:

To make a barrel trap, knock out the ends of a sugar barrel or nail keg. Cut a sheet of wire into circular form so that its diameter will be just twice the diameter of the open end of the barrel. Next, divide the netting into two equal parts by cutting straight through the center; now twist one of the pieces into a cone by bringing the straight edges together. Fasten the edges securely by sewing with twines or fine wire. (The left-over piece will answer for a second trap.) Clip off the point of the cone, leaving an opening a half inch in diameter. Now push the cone into the open end of the barrel, point forward. Securely tack the flare end to the inner side of the rim of the barrel, being careful to make it fly tight at every point. Place a close-fitting wire screen over the other end of the barrel so arranged that it can be removed when necessary. To the cone end of the barrel or trap, as it has now become, attach four legs about 2 inches in height. All is ready for the bait. Place upon a dish a piece of dead fish or some bread and milk to which sugar has been added, or sour milk to which sugar has been added.

Place the trap over the dish containing the bait. Always keep the trap baited. Flies will be attracted to the bait by their sense of smell. After feeding they will be attracted by the light from above, walk up the cone through the hole at the top and become prisoners.

To empty the trap, pour boiling water in from the top. When the flies have been killed, remove the top screen and dump the trap.

The premises must be kept clean or the flies will not be attracted to the traps.

FLY BAITS.

The following interesting account of tests on the relative effectiveness of fly baits is given in War Department Document 897, Notes on sanitary appliances, April, 1919, page 28:

At Camp Greenleaf during the summer of 1918 a three weeks' test was conducted with the Ober flytrap in an effort to find a really efficient bait. It was considered that such a bait should be (1) cheap, (2) always and everywhere available, (3) of such a nature as not to constitute a nuisance. A very careful count was made and kept of the flies. In addition to the house fly, a separate count was made of bluebottles and horseflies. All other insects were counted together, but they were so few in number as to be a negligible quantity and will not be mentioned further. When any particular bait seemed to be very attractive it was carried on through the entire test. The baits used were as follows:

1. Beef liver, in cans, with perforated tops.
2. Mashed cheese and molasses.
3. Sweet corn, in cans, with perforated tops.
4. Fermented canned corn.
5. Molasses, water, and vinegar.
6. Milk, water, and bread.
7. Bevo, water, and bread.
8. Ripe bananas, split longitudinally.
9. Garbage, fermented with yeast.
10. Fermented canned plums.
11. Canned salmon, in cans, with perforated tops.
12. Overripe banana and milk.

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13. Fish heads and fish scraps.

14. Bran mixture No. 1: Bran 3 pounds, cornstarch 1½ pounds, sugar 3 pounds, yeast 4 cakes, water to 5 gallons.

15. Bran mixture No. 2: Bran 2 pounds, corn meal 1 pound, sirup ¾ pound, water 3 pints.

NOTE.—The bran mixtures were allowed to ferment before use.

The total number of flies caught was 43,005. Of these 35,642, or 82.88 per cent, were house flies. The bluebottles numbered 4,444, or 10.33 per cent, and the horseflies 1,732, or 4.03 per cent.

The baits in the order of their efficiency and in their catches were as follows:

	Per cent of total catch.
Fish heads and fish scraps	21.34
Overripe banana and milk	21.30
Bran mixture No. 2	20.72
Canned salmon, perforated top	14.95
Fermented canned plums	7.52
Bran mixture No. 1	5.29
Garbage fermented with yeast	2.25
Ripe bananas split longitudinally	1.83
Bevo, water, and bread	1.58
Milk, water, and bread	1.26
Molasses, water, and vinegar	.99
Fermented canned corn	.63
Sweet corn in cans	.13
Mashed cheese and molasses	.10
Beef liver, in cans	.05

It is thus seen that of the 15 different baits used only 4 seemed to be really efficient, namely:

1. Fish heads and fish scraps.
2. Overripe banana with sour milk.
3. Bran mixture No. 2: Bran 2 pounds, corn meal 1 pound, sirup ¾ pound, water 3 pints.
4. Salmon, in cans, with perforated top.

All of these baits fulfill requirements Nos. 1 and 2 of an efficient bait, but the fish baits fall down on the third requirement, viz, that the bait used shall not constitute a nuisance. The older the fish baits got and the more abhorrent their odor the more efficient they seemed to be.

The four most efficient baits included two of the putrefactive and two of the fermentative type. The odor given off by the latter is pleasant rather than otherwise. While the percentages given have all referred to the house fly, it may be stated that the two fermented baits were the most efficient as far as the blue-bottle and horseflies were concerned.

It seems to be necessary for a bait to have either a fermentative or putrefactive odor to be efficient.

FLY SWATTER.

The use of fly "swatters" about the house is strongly to be recommended. Placed in the hands of children who have been taught at an early age the danger of flies, swatters can be made very effective.

FLY PAPER.

Sticky fly paper is a convenient and effective means of disposing of flies.

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MOSQUITOES.

Some varieties of mosquitoes are carriers of disease, including malaria and yellow fever. The female of one variety,[3] Anopheles, can acquire malarial parasites by biting a person who has them in his blood and can inject them into other persons whom she later bites, thereby spreading the disease.

Mosquitoes breed[4] in stagnant, preferably dirty, pools. The females of some varieties lay eggs one at a time; the females of other varieties as many as 300 at a time, which float on the surface of the water in the form of a raft an eighth of an inch or more in length, that can readily be seen with the naked eye. In about two days the eggs hatch and form the larvæ or "wrigglers," to be seen so frequently in rain barrels. The larvæ breathe air through a tube a little to one side of one extremity. If their air supply is cut off they die. In about a week each larva changes into a chrysalis from which about two days later the mosquito emerges.

Mosquitoes can be destroyed by draining or treating the places where water collects. Old tin cans, bottles, or any waste vessels that will hold water should be removed or destroyed. Tubs and barrels used to store water for domestic purposes should be kept covered so that mosquitoes can not enter to lay eggs. Holes in trees or stumps, roadside puddles, and depressions in rocks should be filled. Ditches should be kept clean so as to permit a free passage of water through them. Edges of pools should be kept free from grass, and marshes should be drained. Where draining is not practical, stagnant water should be sprayed at frequent intervals with kerosene or crude oil. The oil forms a scum on the surface of the water and prevents the larvæ from getting air. Large ponds may be stocked with fish, which feed on the larvæ.

As a rule, however, mosquitoes are not a menace to an oil camp, because sooner or later oil accumulates on practically all of the stagnant water about the camp. For further information on methods of exterminating mosquitoes the reader is referred to the bibliography at the end of this paper.

LOCATION OF CAMPS.

A camp should be on well-drained ground. Even though it be necessary for the men to walk a short distance to and from work, this rule should be followed. The living quarters, kitchen, and commissary houses should be on the higher ground, with the stables, corrals, and chicken pens on the lower, so that surface drainage will be always from the former toward the latter.

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[3] Carter, H. R., Malaria, lessons in its cause and prevention: U. S. Public Health Service, Supplement 18, 1916, p. 10.

[4] Keeney, Robert M., The menace of mosquitoes and what to do about it: Mining and Scientific Press, vol. 109, Aug. 29, 1914, p. 334.

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Until success in drilling has determined that the camp is to be permanent, temporary bunk houses on the plan of the smaller cantonment buildings recently used by the United States Army should be satisfactory. It is well to arrange the houses in accordance with modern town planning, as this will add greatly to the appearance of the camp and will facilitate keeping it clean. If there is any prospect that the camp will become permanent, trees—unless they are already on the site and can be cleared to harmonize with the surroundings—should be planted in neat rows about the buildings, and every encouragement should be given employees to plant lawns and gardens.

SPACING OF BUILDINGS.

Spaces between buildings must largely be determined by the price of the land plus the cost of water-supply pipes, sewerage, gas mains, light lines, and other services, as well as by the kind of people who are to occupy the houses. Hard and fast rules can not be laid down unless there is to be close sanitary supervision. It is good practice to place dwellings at least 25 feet apart; 75 feet is preferable where possible. Figure 1 shows a good layout for a pumping station.

In a well planned layout for a drilling camp the kitchen, dining room, and commissary buildings should be at least 200 feet from the sleeping quarters; and the stables, corral, and chicken coop at least 800 feet from the kitchen and dining room and 600 feet from the dwellings. On account of the cost of land and the proximity of buildings already erected, the adoption of such a plan may not be possible; most oil drilling, however, is done in rural districts where holdings or leases are relatively large, and as a rule it is entirely feasible to lay out a camp according to a plan that will insure healthful conditions.

Toilets, if the pit type is used, should if possible be at least 50 feet to the rear of the houses. However, in the writer's opinion, this type of toilet or any other that does not preclude the possibility of flies coming in contact with the excrement before it can be properly disposed of is dangerous. No matter what efforts are made to screen such toilets and keep them fly proof, it is only a matter of time until, through checking of the boards or carelessness of the users, flies are admitted and become a menace to the health of everyone about the camp. If the camp is of such a temporary nature that the use of privies seems advisable, the danger from them should never be overlooked, and they should be built and kept fly proof. A preferable type of sewage disposal for camps is the water-carriage system and septic tank, which is now being installed at the oil camps and pumping stations of many of the larger companies; this

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A. PART OF PUMPING STATION, SHOWING IMPROVED CONDITIONS PROVIDED BY THE COMPANY FOR ITS EMPLOYEES.

B. HOUSE FOR EMPLOYEES AT PUMPING STATION, SHOWING IMPROVED LIVING CONDITIONS DUE TO COOPERATION BETWEEN COMPANY AND WORKERS.

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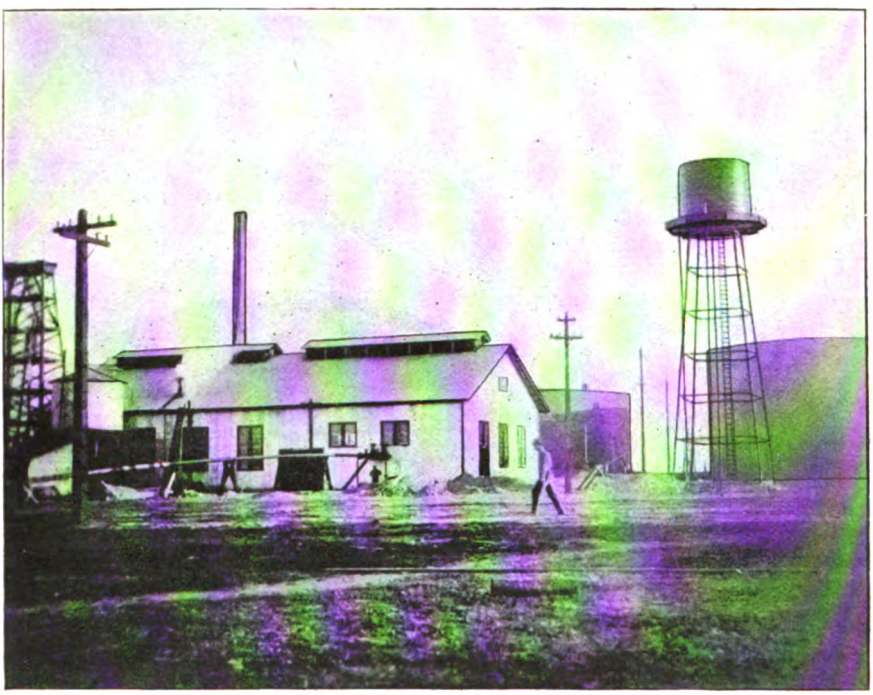

DOMESTIC TANK AND TOWER USED TO FURNISH PRESSURE FOR WATER WHERE GRAVITY HEAD IS NOT AVAILABLE OTHERWISE.

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system will be described later under the heading of sewage disposal. It is not, as many people think, excessively expensive.

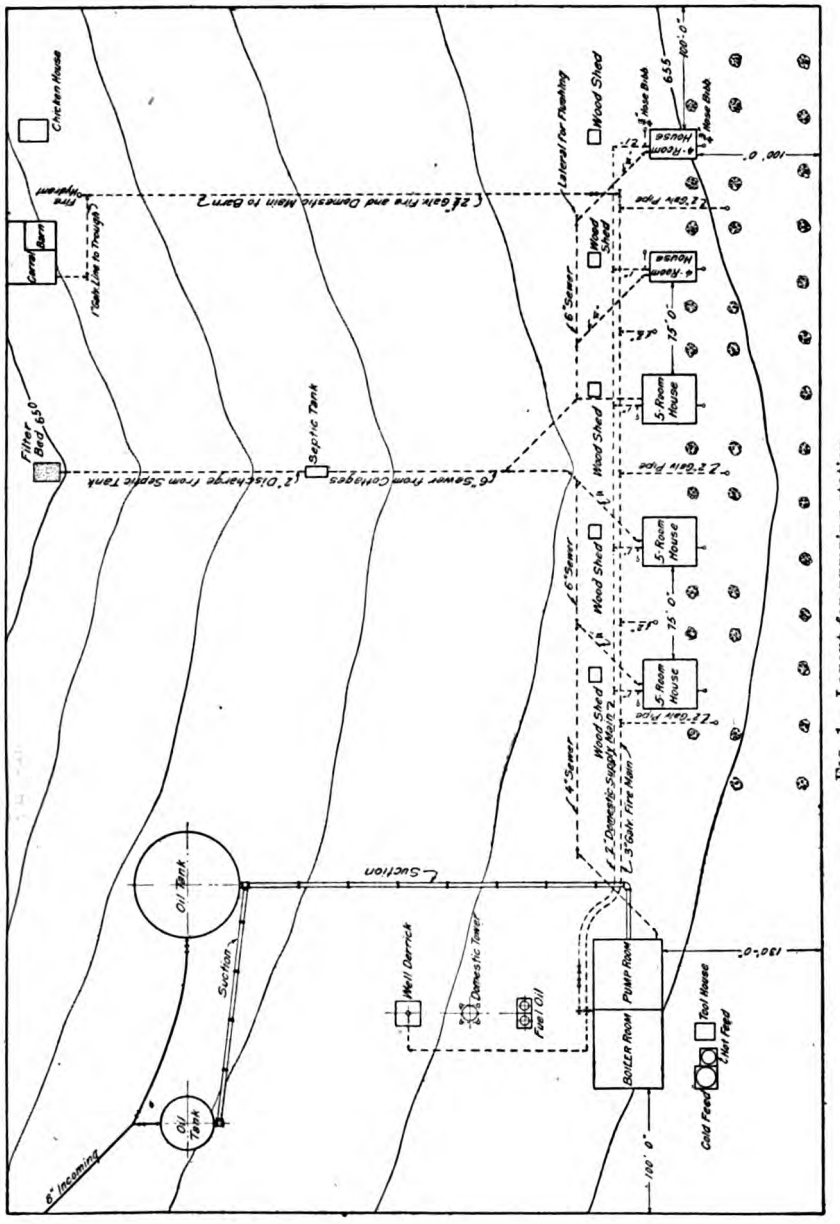

FIG. 1.—Layout for pumping station.

Plate I, *A* and *B*, shows what cooperation between the company and its employees can accomplish in the improvement of living conditions in a comparatively short time. The dwellings have

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screened porches on three sides and are surrounded by trees and lawns. The station here shown is also equipped with a water-carriage sewer system and septic tank.

HOUSES.

For camps that are to be in use for a year or more it pays to construct durable buildings. Particular care should be given to foundations, for which concrete slabs or piers having sufficient bearing areas to uphold the superimposed load are preferable. If wooden mudsills are used, care should be taken that they have ample area and are set level on solid ground and not carelessly on loose soil. In swampy ground, as in parts of Louisiana and Texas, a substantial pile foundation should first be constructed, for the reason that even a light wooden structure, such as a camp building, can easily be kept in repair an indefinite length of time if placed on a strong foundation, whereas if a building is set on a poor foundation, the door and window frames will soon sag badly and in a short time become almost useless.

For cold climates, the walls and floors of the buildings should be double, and the buildings should be constructed in every way so that they can be kept comfortably warm during the winter. In warm climates, lighter construction may be used. For comfort in summer weather, the houses should have verandas and ample window space. When it is desirable that the verandas be screened in summer, the screening wire should be attached to well-constructed frames of convenient sizes which can be taken down and stored in winter. Although its first cost is higher, bronze screening, 14 to 16 mesh, will be found the most economical screening in the long run in some climates, as along sea coasts, for with reasonable care it will last several seasons. In such climates the ordinary dipped or galvanized screening will rust through very quickly, once the protective coating is destroyed; it can be repainted, but not always satisfactorily.

Figure 2 shows a type of house used in a mild climate by a California oil company. For particulars concerning houses suitable for different climates, the reader is referred to a Bureau of Mines bulletin.[5]

Tents and tent houses can be recommended for only the most temporary kind of camps; they are hard to ventilate, are cold during the winter, and often are unbearably hot in the summer unless equipped with a "fly" or double roof. In many climates, the repeated wetting and drying due to the rain and sunshine in a relatively short time will so rot the fiber of the canvas that a moderate wind storm will tear the tents to pieces. Where it is necessary to

[5] White, A. H., Houses for mining towns: Bull. 87, Bureau of Mines, 1914, 64 pp.

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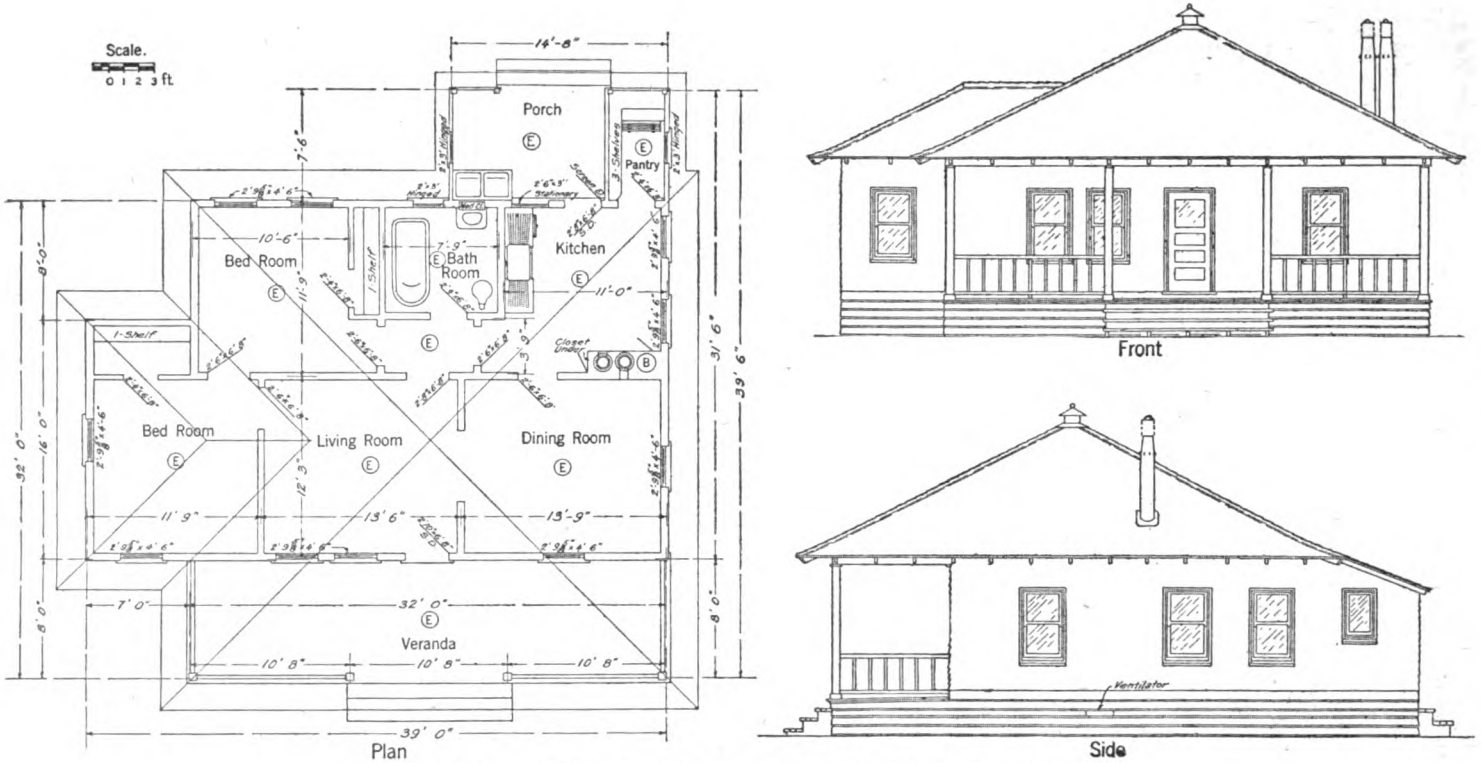

FIG. 2.—Five-room dwelling designed for employees by a California oil company.

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use a stove in a tent, glowing sparks from the stovepipe may fall on the roof and burn holes in it, causing it to leak.

At drilling camps, it is particularly desirable to see that men bunking in the same room work on the same tours, or on tours so arranged that those who are trying to sleep will not be disturbed by their roommates.

Whether tents, temporary buildings, or permanent buildings are used for sleeping quarters, the rooms should be of such size as to afford at least 500 cubic feet of air for each person, and the men should be encouraged to keep their rooms well ventilated at all times.

Tents used for temporary camps should be provided with floors at least 12 inches off the ground, and proper drainage should be maintained around them to keep the floors dry.

The cook house, dining room, and commissary houses should have all openings screened, and the doors should be fitted with spring hinges, coils, or some similar arrangement that will close them automatically. Double doors, built in the same way as storm doors, are effective.

WATER SUPPLY.

A plentiful supply of pure water for domestic use should be provided. If the source of the supply is a spring, it should be housed in and carefully guarded against possible contamination. Cesspools or privy vaults should be so placed that pollution of the water supply is impossible. If a stream is used as a source of supply, it should be shut off from cattle or other stock by fencing it for a reasonable distance above the intake, and the intake itself should be carefully screened and cleaned as often as necessary to keep the water free from organic contamination. A small stream is usually a dangerous source of supply, as it is often difficult to protect it properly. Wells, if used, should be protected against surface drainage, and the same precautions as for springs should be taken against cesspools and privy vaults.

Water should be furnished to the various houses and dwellings through pipe lines, and the pressure at the tap or hydrant at all times should be at least 20 pounds per square inch. This pressure can be had by means of a domestic tank and tower, such as are shown in Plate II, if an ordinary gravity system is inadequate. A small gasoline engine placed at the well or spring and operated a few hours each day will keep the tank filled. During periods when the atmospheric temperature is below freezing, it may be necessary to operate the pump continuously in order to maintain a circulation through the tank and the exposed portions of the pipe lines as protection against freezing. An extremely cold climate necessitates other modifications in the system.

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With a domestic tank and tower it pays also to install a separate system of piping for fire lines. The smallest pipe used in such a system should be at least 2 inches in diameter, and the pump should be capable of developing a line pressure sufficient to furnish the required amount of water. Figure 1 (see p. 13) shows a good arrangement of fire and domestic lines.

Periodic examination of the water supply should be made, especially where the supply is from a surface source or from shallow wells.

When the purity of the water is questioned, a bacteriological analysis should be made and immediate steps taken to overcome the contamination. Practically all State boards of health in the United States are equipped to make the required analyses. Complete information as to the steps being taken to purify the water supply (if this proves necessary) should be given to the employees at the camp, as many people, especially in hot weather, are inclined to attribute all ailments, no matter of what nature, to defects in the water supply.

DRINKING WATER.

Drinking water should not be kept in a barrel to "keep it cool" in the summer time, neither should a common cup be furnished. A far better plan for furnishing cold water is to arrange a coil of pipe through an ice chest, from which a gallon or more of ice water may be drawn at a time. In hot climates each house should be furnished with an unglazed earthen jar (called in southern States an "ollan") of about 2-gallon capacity. If such a jar is filled with water in the morning and permitted to stand or hang in a free circulation of air, it will keep the water remarkably cold, even in the warmest weather, without the use of ice. These jars should be cleaned and sunned at frequent intervals. Some waters will form a scum inside the olla, after the latter has been in use for a period of time, which can be removed by scrubbing with cold water and a brick bat or with brick dust. The use of hot water for cleaning is not always desirable, as it tends to fill the pores of the jar with foreign materials and impairs free percolation of the water.

When barrels are used to hold drinking water, as for field gangs laying pipes, the water should be drawn through a faucet and a tight cover kept on the barrels to prevent the men from dipping in a cup and to keep insects from entering. The barrel should be frequently and thoroughly washed and scalded.

The use of individual drinking cups should be encouraged. Drinking fountains that are so constructed that the lips can not come in contact with the orifice should be used wherever practicable.

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SHOWER BATHS.

Shower baths should be provided for the men, even those who live in tents or temporary buildings not equipped with bathtubs. These showers should provide warm water during the winter and should be placed within a reasonable distance of the sleeping quarters. An improvised shower bath for a temporary camp may readily be made out of a barrel (elevated to give enough head), a supply pipe, and a perforated tin can, if more modern facilities are not available.

WATER BASINS.

A liberal supply of washbasins should be provided and should be scalded or otherwise sterilized at frequent intervals. The roller towel in the wash room is insanitary and has become obsolete; in fact, some States prohibit it by law. The use of individual towels should be encouraged.

DISPOSAL OF GARBAGE.

At temporary camps garbage may be buried in the ground, but at permanent camps it should be disposed of either by burning or feeding to hogs. It should not be fed to poultry, as chickens will not consume such things as the peelings of most vegetables or coffee grounds, which afford breeding and feeding places for flies. Hogs should not be allowed to roam about the camp, but should be penned, and the pens kept clean, so that they, too, do not become breeding and feeding places for flies, as even hogs will not consume coffee grounds and some kinds of melon rinds.

The most sanitary way to dispose of garbage is by incineration. For a small camp of 50 to 60 people garbage can be conveniently burned in a pit about 4 feet in diameter by 3 feet in depth; into the pit, the garbage should be dumped in as dry a state as possible, liberally sprinkled with crude oil, and burned. In a larger camp it will usually be possible to arrange with a farmer in the neighborhood to gather the garbage at stated intervals, free of charge, for hog feed. This is a much more economical way of disposing of garbage than by burning it, as by this method all its value is conserved. A complete description of different types of garbage incinerators is given in the November, 1915, Advisory pamphlet on camp sanitation and housing, issued by the Commission of Immigration and Housing of California, pages 17 to 24.

Garbage and similar refuse should be kept in galvanized-metal, fly-proof covered containers, until it can be disposed of permanently. It should be placed in the containers in as dry a condition as possible, as water standing in the bottom of the can will soon rust it through, and permit flies to enter. For a small household of two to six

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people, no more effective method can be devised for collecting the kitchen scraps than for the housewife to form the habit of first draining the water from them and then placing them in an old newspaper. The garbage can be wrapped up in the newspaper and placed in the garbage can. This process is convenient for the housewife, insures dry garbage going into the container, and—what is even more important—the garbage thus wrapped does not adhere to the sides of the container to become a breeding place for flies.

TIN CANS.

Few people realize the danger in permitting tin cans to lie about the camp. A part of the contents, whether vegetable, fruit, or meat, remains in the can after it has been opened and emptied. As there is no passage of air through the can, this material may not dry up for several days and offers a feeding and breeding place for flies. Cans partly filled with rain water also afford a breeding place for mosquitoes. All cans should be gathered up immediately after they have been emptied, crushed and burned with other refuse, or buried in the ground.

KITCHEN SLOPS.

At temporary camps accommodating a large number of persons the disposal of kitchen slops sometimes becomes a difficult problem. The usual method in such camps is to dig a pit about 3 by 3 by 4 feet, and place a tight board cover over the top to keep out the flies. The slops are poured into the pit through a hatch, which is kept carefully closed when not in use. The pit should be dug in soil as permeable as can be found, and should the liquid fail to percolate into the soil within a reasonable time a new pit should be dug and the old one filled with earth as soon as conditions permit.

In congested areas and at large camps, such as military camps, evaporative systems[6] have been used to dispose of kitchen slops. These are usually operated in connection with incinerators, but in some camps are separate installations. As they require a great deal of attention, the author does not believe they are so suitable for small oil camps as the septic system to be described later.

DISPOSAL OF STABLE REFUSE.

Manure piles are favorite breeding places for flies, and should not be allowed to accumulate. Stables should be thoroughly cleaned daily when in use, and the manure either hauled into the field and spread in thin layers on the land or placed in properly constructed compost pits[7] or burned.

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[6] Shewbrooks, Maj. Daniel M.: Military Surgeon, vol. 42, 1918, p. 180.

[7] For description of a composting pit with bill of materials, see Commission of Immigration and Housing of California, Advisory pamphlet on camp sanitation and housing, November, 1915, p. 50.

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If manure is spread in thin layers in the field, not to exceed 1 inch in depth, its rapid desiccation soon makes it unattractive to flies. The heat of the sun will kill the eggs and the larvæ in a short time. When it is not practicable to dispose of manure promptly, fly breeding may be prevented by sprinkling with a solution of hellebore. About 1 gallon of the solution should be used to every cubic foot of manure. Such treatment will destroy 99 per cent of all fly larvæ present and the treated manure is not poisonous to chickens; neither is its value as a fertilizer impaired.

SEWAGE DISPOSAL.

There is probably no one subject upon which sanitary engineers are more thoroughly in accord than the inherent vileness and danger, even under favorable conditions, of the open privy closet and the cesspool as ordinarily constructed. Fresh sewage is not always injurious to health, nor is its odor usually very offensive, but putrefying excreta and kitchen slops, especially during hot weather, are not only offensive, but they become breeding places of myriads of flies, which carry on their feet and in their bodies disease germs that may be deposited on the food eaten by the workmen and their families.

THE OPEN PRIVY.

In camps of a very temporary nature—lasting not more than a few months—the privy type of toilet may be permissible, but it must be kept at all times sanitary, and both the pit and the housing should be made and kept fireproof. All openings, including knot holes, should be screened and cracks between boards should be carefully battened. The bottom of the housing must be banked with earth so that there will be no opening between the bottom sill and the ground. The doors should have spring hinges, coils, or some other arrangement that will insure their closing automatically. As an added precaution, each seat should be provided with a cover arranged to drop automatically over the hole, and the surface of the excreta should be kept well covered with crude oil or lime. The pit should never be less than 5 feet deep and when it is half filled a new pit should be dug and the building moved over it; the old pit should be first burned out, then filled with earth.

Such a system of sewage disposal can in no case be recommended for permanent adoption and can be used with safety only when constant vigilance keeps the buildings fly proof. Plate III, *A* and *B*, photographs taken near a Texas oil town, indicate the usual condition of such toilets.

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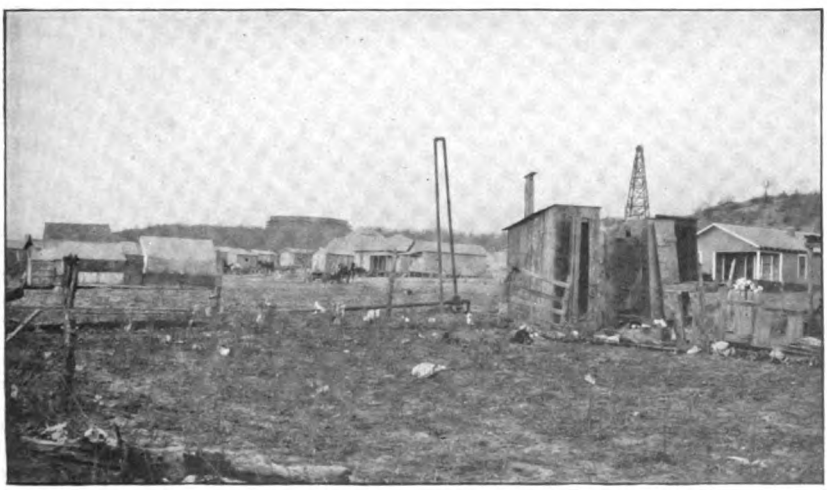

OIL-FIELD TOILETS IN TYPICAL UNSANITARY CONDITION.

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REMOVABLE RECEPTACLE PRIVIES.

A removable receptacle privy consists usually of a suitable water-tight receptacle, incased in a substantially built fly-tight wooden box, which serves as a seat. The hole in the top of this box is covered with a hinged lid and the lid is usually screened to provide proper ventilation. The lid is also arranged to drop in place by its own weight when the privy is not in use. Either the top or the front of the box is also hinged to permit the removal and cleaning of the receptacle.

This type of sewage disposal is recommended by some authorities as preferable to the open-back privy. The success of such a system depends on constant care, as periodic emptying and cleaning of the receptacle and keeping the box fly proof are absolutely necessary. If not properly constructed and cared for, after a few months of service the lid of the box may warp and not fit closely over the hole, the box may check, and the door may sag, so that flies have comparatively free entrance, and protection against the spread of contagion may be little better than with the ordinary privy. However, when given the proper care, this system has been and is rendering good service in many places.

CHEMICAL CLOSETS.

Chemical closets are now being placed on the market by certain manufacturers. The bulletin of the Kansas State Board of Health, August, 1918, gives the following description and opinion of this kind of sewage disposal:

A chemical closet is one whose primary object is the chemical disinfection of excreta. This is accompanied by more or less liquefaction according to the nature of the chemical used. The result is accomplished by the introduction into the receiving can, tank, or other device of an aqueous solution or emulsion of a chemical substance or mixture supposed to possess germicidal and, in certain cases, deodorizing and liquefying properties. There are at least two general types of chemical closets. One of these depends upon the action of an alkaline emulsion of a coal-tar or other oily disinfectant, the principal object being disinfection and deodorization, and the other upon a strongly caustic solution with or without other disinfectants with the additional object of rendering the tank contents semiliquid. These closets generally possess, in common with other types of privy, special devices for ventilation. In distinction from other privies, their installation within the house and even in the bedroom or other dwelling room is being recommended by the manufacturers. Among the special advantages claimed are all the conveniences of the inside water-closet, simplicity of operation, and ease and safety of disposing of the liquid material, with entire freedom from any objectionable or obnoxious features.

Without undertaking any description of specific makes of chemical closets, it seems highly desirable to inquire into the general merits of this system and

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to see to what extent they comply with the essentials of a sanitary system as outlined. The various devices are primarily water-tight receptacles so constructed that access of flies and animals is reasonably prevented, although the mechanical details of certain constructions are not such as to guarantee this result. Instances have been observed in practice where the sliding parts from the connection to the lower receptacle, through perhaps unnecessarily rough usage, have been so bent out of shape as to destroy the original function of the tightly fitting sleeve. This, however, is a matter of special design and of proper use and upkeep and need not be charged against the principles of the system.

In the secondary matters of privacy, convenience, and freedom from odors, these devices, with their special provision for deoderization and for ventilation, are specially commendable. They are also capable of cleanly operation, and if so operated they comply with the definition of a sanitary privy, subject to the further requirements of a means of final disposal of the contents in a way that shall be incapable of transmitting disease. To this end chemical closets place primary reliance upon disinfection. If this be at all times satisfactory and if, in addition, the actual physical disposal of the disinfected material be made with due regard to common decency and cleanliness, the system complies satisfactorily with the requirements of a sanitary system. The essential condition, therefore, is the efficiency and sufficiency of the disinfection itself. In this connection there are certain distinct drawbacks to the system, not as it is laid down in the descriptive pamphlets, but as it would be operated under practical conditions.

Such protective factors as physical removal to a distant point are capable of ready appreciation upon the part of any person concerned, and, once appreciated, encounter no special difficulties in the way of their complete and satisfactory performance. Where the chief reliance is placed upon the action of a chemical, always a mysterious substance in the mind of the layman, there is much more likelihood of neglect through ignorance, carelessness, failure to order or receive a proper supply, or mistaken ideas of economy. The sufficiency of the system of disinfection recommended, when carried out in accordance with instructions, has been satisfactorily demonstrated in some cases with reference to certain organisms of disease. There is, however, a dearth of reliable information upon this point, and in particular it must be noted that the destruction of hookworm eggs, a consideration of great importance throughout a large section of the country in which installations of this type of closet are most likely to be made, does not seem to have been satisfactorily investigated.

There is also the possibility of misuse of the principles of the chemical closet upon the part of unscrupulous manufacturers, resulting in the employment of chemical substances quite worthless for the purpose and in the placing of such reliance upon imperfect disinfection as to result in serious consequences. It would seem to be incumbent, therefore, upon the manufacturers of such devices to make such thoroughgoing tests of the efficiency of the chemical substance to be employed, not only against the more common pathogenic bacteria, but also against the much more resistant hookworm eggs, as shall be satisfactory to State and local health authorities, and to furnish suitable guaranties of the constancy and permanence of such chemicals. In particular, these tests must be made under practical working conditions, as the value of the phenol coefficient employed in the standardization of commercial disinfectants may be of minor significance in this connection.

Some criticism has been made of the suggestion of installing chemical closets in the living rooms of the home, but this is believed to be more a matter of

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esthetics than of health, and with proper safeguards as to ventilation, no reasonable objection can be raised against the practice upon sanitary grounds. Neither is it necessary to take into consideration questions of costs of installation and of operation, as these are matters which will be weighed in each individual case against convenience and comfort. It is obvious that the cheaper the installation which will comply with all public health and esthetic requirements the more general will be its adoption.

In brief, then, everything depends upon the sufficiency of the disinfection and the means of final disposal. No system should be installed or recommended for installation in the absence of definite and satisfactory evidence that the treatment proposed will in fact destroy pathogenic (disease-causing) bacteria, and in those sections of the country where hookworm disease is prevalent, the eggs and larvæ of hookworms. While the design and satisfactory operation of such a device is quite possible, its general adoption ought not to be recommended without giving the fullest consideration to the possibilities of mismanagement, and it is believed that whatever means are adopted for final disposal, these should be so safeguarded that the almost inevitable failure at times of the chemical toilet may not result in serious danger to the health of those affected.

TYPE OF CHEMICAL CLOSETS.

There are two general types of chemical closets.

The commode type usually consists of a permanent fixture ventilated to a flue or through the roof. A removable receptacle is placed under the seat of this fixture and a quantity of disinfectant used in this bucket.

With this type it is necessary to remove the contents and bury it once every two or three weeks.

The other type consists of an indoor fixture very similar to the ordinary seat used in the water-carriage systems. A tank is provided for the collection of excreta, and the disinfectant used in the tank is sufficient to render the contents semiliquid and thoroughly disinfect it. The tank type does not have to be cleaned more than once in six or eight months.

Typical installations of both of these chemical toilets have been in operation in the public toilet rooms of the University (Kansas) buildings. The commode type was operated four months and the tank type fourteen months. No complaint of nuisance was made in either case. The commode type gave very satisfactory results, as all organisms of intestinal origin were killed. The tank type effected complete sterilization for the whole period of time. During the last six months of the operation of the tank type toilet no attention was given it, the object being to see if it could under any circumstances create a nuisance.

These commercial devices of course have their faults, but, operated according to directions, will be of great benefit to the public-health movement in rural districts where water-carriage systems are not possible.

CESSPOOLS.

In the past it has been the practice at permanent camps and in many small cities and towns to convey sewage by a water-carriage system into a cesspool; because the cesspool was covered up and so far from the buildings that the noisome gases did not become a nuisance, it was supposed that the sewage was being disposed of properly.

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Undoubtedly there are places where this system properly disposes of the sewage, but in the author's opinion such places are the exception, as the successful operation of a cesspool depends on septic action. To insure septic action, the surface of the water in the pool should remain at practically a constant height; that is, the water should seep into the soil at the same rate it enters the pool. This, of course, is seldom possible. On wash days, for example, there may be an influx of water that will almost fill the cesspool. When the water recedes, the scum of bacteria and excreta on the surface will stick to the walls of the excavation, and if the cesspool is not properly covered it will, like the open privy, afford a breeding place for flies. When the sewer system is not in use, as during the vacancy of buildings, all the water may seep out of the cesspools and the scum of excreta and bacteria left behind may cover the bottom as well as the sides. Repeated occurrences of this kind may so affect the porosity of the soil that the water will cease to percolate through it, with the result that the pool overflows and becomes a positive danger to everyone living in the vicinity. Any type of sewage disposal that does not preclude the possibility of flies coming in contact with the excreta or other waste material is unsatisfactory.

SEPTIC TANKS.

A septic tank is simply a nonleaching (water-tight) cesspool provided with an overflow and is not necessarily, as is generally believed, a complicated and costly structure dependent on careful attention for satisfactory results. Its installation is comparatively simple. The septic tank is well adapted for use in almost any part of the United States and costs only a little more than the ordinary cesspool.

The purpose of the septic tank is to separate and settle from the liquid as much as possible of the solid material in the excreta and to destroy the solid material by bacterial agencies. Part of the material will settle in a short time, part will remain in suspension for a long time, and some is so finely divided that trying to settle it out probably would be impracticable. The theory of operation is that the solid matter is attacked by countless bacteria, which change most of it into compounds, part liquid and part gaseous. Some of the solids rise and form a scum over the surface of the liquid, whereas others sink to the bottom of the tank. As this scum excludes the light and air and may be regarded as an aid to septic action, it is desirable that it should remain undisturbed except when the tank has to be cleaned.

Septic tanks are built in several different forms, some of which are more or less elaborate, with automatic siphon discharges. The tank shown in figure 3 is one of a number constructed some years

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ago by the Associated Pipe Line Co. at pumping stations along the trunk line from Bakersfield to Port Costa, Calif. It is 18 feet long, 6 feet wide, and 8 to 12 feet deep. It has ample capacity to take care of the sewage from five cottages, a pump and boiler house, and one bunk house, representing 30 to 40 people. The tank is probably larger than is necessary, as it is the practice to make the capacity of such tanks equal to about a 24-hour flow of sewage. However, as the sewage travels only a comparatively short distance before entering the tank, it was thought best to adopt a design of ample capacity to insure as complete septic action as possible.

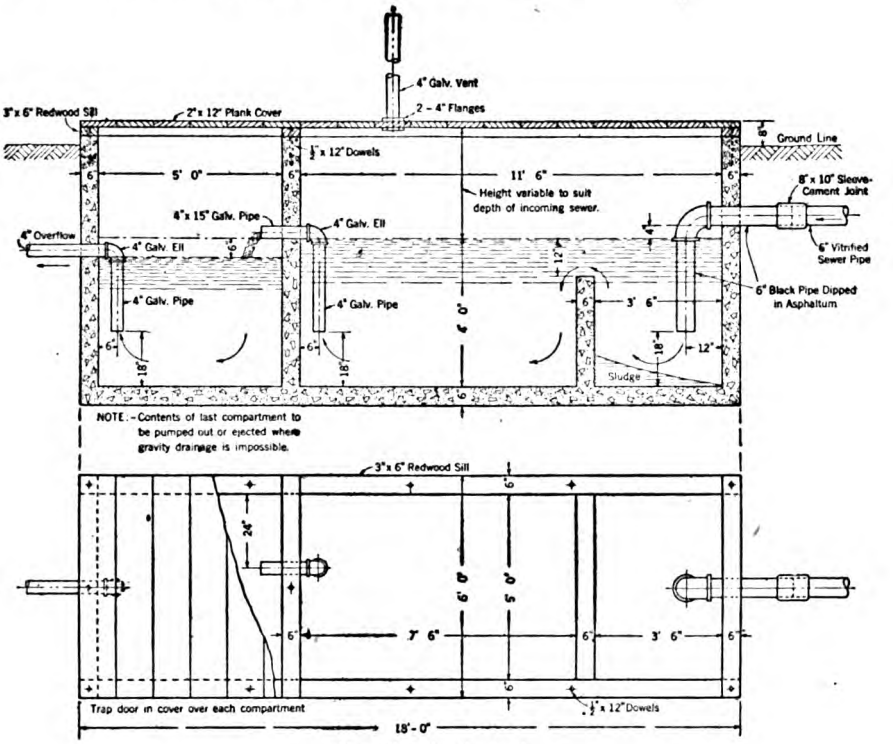

FIG. 3.—Septic tank.

The tank is built of concrete, 6 inches thick, and comprises two main compartments. In the larger compartment, shown on the right in the drawing, is a division wall extending from the bottom to within 12 inches of the surface of the water, making virtually a third compartment about 3 by 3½ by 5 feet, which receives the incoming sewage. The object of this wall is to make sure that all sewage entering the tank will at some time be forced to rise to a point near the surface and not be swept along the bottom of the tank and out the overflow pipe by an unusually large influx of water, before dissolution takes place. With this arrangement, under normal conditions, the effluent which is discharged into the second compartment of the tank

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shown on the left of the drawing contains probably only a small amount of matter in suspension.

If the tank can be so placed that drainage from the main compartment will discharge through the outlet to a cinder bed or sand filter, the last compartment is not really essential. The third compartment is essential, however, when it is necessary to place the tank at so low a point that there can be no final drainage from it, in order to secure the proper gradient for flow from house fixtures. Under this condition the effluent must be removed from the outfall compartment by a pump or by a steam ejector. This process alters the surface of the water very rapidly and at times may even agitate it violently. Were such agitation to occur in the main compartment of the tank, it would remove or destroy many of the bacteria under the surface scum with possibly fatal results to the success of the dissolution, because quietude is essential to the life and propagation of the bacteria that satisfactorily perform dissolution.

When the effluent has to be pumped, a float is arranged in the outfall compartment to indicate the position of the water, and steam is turned into the ejector and the pumps are started before the water has risen high enough to disturb the surface of the main compartment. It has been the practice of the Associated Pipe Line Co., in those septic tanks where pumping is required, to design the outfall compartment large enough to accommodate the maximum flow in 24 hours from all possible sources and to pump out once during that period, as a part of the routine. If desired, the pumping could be arranged to operate automatically.

The top of the tank, which is placed about 8 inches above the surface of the ground to exclude run-off waters, is covered by 2 by 12 inch planks laid flat. In places subject to heavy winter snows a gable roof would be preferable. Other changes might be necessary to adapt the tank to climatic conditions.

In some of the tanks a vent pipe 4 inches in diameter and 12 to 15 feet high has been placed in the larger compartment to carry off the gases; in others, this pipe has been omitted. There is no appreciable odor about the tanks, but the vents are undoubtedly desirable even when the houses are properly trapped, as they will prevent accumulations of gases which under some conditions might be highly inflammable. It is, of course, necessary to remove the sludge which gradually collects on the bottom of the tanks. The Associated Pipe Line Co. has found that cleaning is required not more often than once or twice a year.

The rest of the system follows so closely an ordinary modern city sewerage system that it will not be described in detail. Six-inch vitrified sewer pipe is used for the main runs, and four-inch for the laterals leading from the houses. The house fixtures comprise

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the usual enamel-ware kitchen sink, bathtub, toilet, washbasin, and washtubs, trapped and vented in the customary manner. The sewer pipe should be placed on a true gradient, that is, there should be no sags in the pipe where sewage can collect and clog the system. This is very important. The minimum gradient should be not less than one-fourth inch per foot. If changes in grade or alinement are necessary, manholes should be constructed at these points to enable easy access to the sewers in case of clogging.

FILTER BEDS.

The tanks used by the Associated Pipe Line Co. discharge the effluent directly from the last compartment into the soil and although they have been in use over 10 years there seems to be no ill effect from so doing. However, the author believes that this is a mistake and that no septic system is complete which has not a properly constructed filter bed to receive the effluent from the septic tank, or, where conditions are favorable, a subsurface irrigation system of drain tile laid beneath the surface of a light aerated soil. This is important, as the liquid may often carry in suspension a relatively large amount of organic matter that may still be a menace to life and health.

"Aerobic" bacteria (bacteria requiring oxygen from the air) live in the upper layers of the soil and, if given the opportunity, will attack the suspended and dissolved organic matter in the effluent from a septic tank and will effect a further purification so that the water flowing from a properly constructed filter bed or successful subsurface irrigation system should be clear, inoffensive, and sufficiently harmless to be discharged into any stream not used as a drinking supply.

The reason why the septic systems used by the Associated Pipe Line Co. are giving such good results is undoubtedly because the soils upon which the effluent is discharging have so far furnished the necessary filters. How long this will continue is problematical, as the application of the sewage to the filter must be carried on in such a manner that a frequently periodic supply of air at least also will circulate through it. Unprepared soil may in time become so clogged and the supply of oxygen will be so decreased that the bacteria can not live and the sewage will pass through unpurified.

A sand filter, which in size and construction seems particularly well suited for use with the septic tank described above, is shown in the "Official Publication of Iowa State College of Agriculture and Mechanical Arts," volume 15, No. 9, page 28.

Figure 4 gives a section and plan of the filter and the following is a description of its construction and use:

The filter is 15 by 20 feet in surface area and 2 feet deep, constructed of ordinary clean, coarse, mortar sand (with pebbles over the underdrains and at the

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intake). Underdrains laid longitudinally in trenches along the bottom of the bed conduct the filtered sewage to the outlet, while vent pipes extending from them to the surface assist in supplying air to the bed.

If the contour of the ground surface permits the selection of an area within reasonable distance somewhat lower in elevation than the siphon discharge pipe, the filter bed can be constructed with little or no excavation—only enough to level off the required area and provide dirt banks to hold the sand. The sewage should then be carried in joint-tight sewer pipe from the siphon to the bed, using a good grade to expedite the flow.

If the ground is level, or nearly so, an excavation of sufficient depth will need to be made for the filter, preferably immediately adjacent to the tank. The

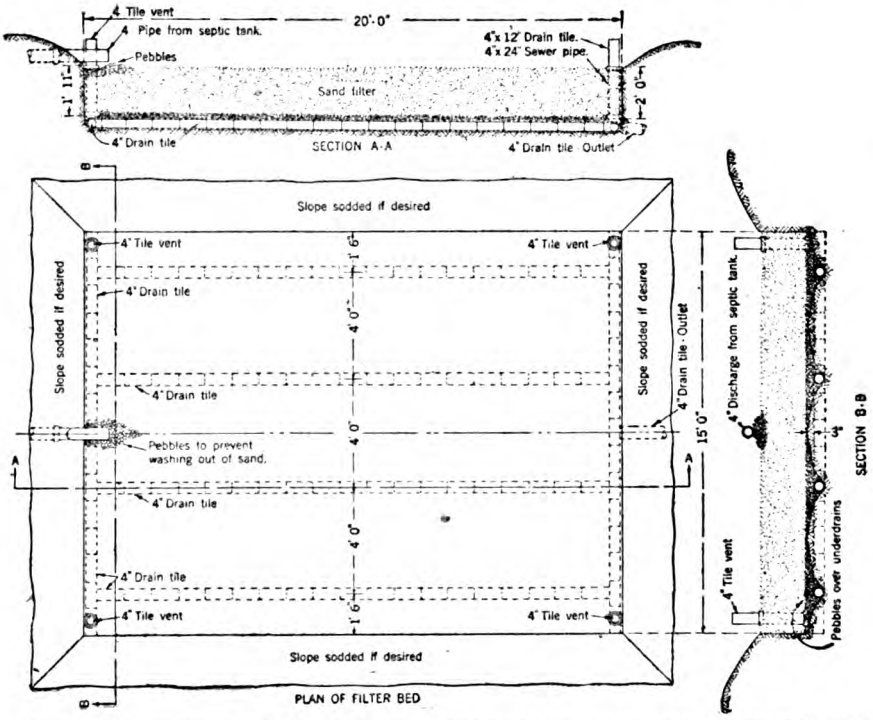

FIG. 4.—Plan of sand filter to be used in connection with septic tank. From "Official Publication of Iowa State College of Agriculture and Mechanical Arts," vol. 15, No. 9, p. 28.

banks should be sloped back from the surface of the sand and sodded to prevent washing of the dirt onto the bed.

Special care should be exercised to keep the filter surface perfectly level and thus insure an even distribution of the sewage. If one part is lower than the rest the sewage will naturally seek it out and that part will be overworked.

The very fine material held in suspense in the sewage and passing out onto the filter bed gradually forms a seal at the surface which interferes with the filtering process. Especially is this true of sand filters. If the bed appears to be covered with a fine black sediment and the sewage is perceptibly retarded in passing away, the surface of the sand should be loosened with a rake. Failing thus to aid filtration sufficiently, enough sand should be removed from

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the bed to show a clean surface—a very thin layer is usually sufficient. If the sewage stands on the bed after the above measures have been taken, the outlet drain should be examined for possible clogging.

* * * Sand filters should receive special preparation for the winter months by the formation of ridges and furrows on the sand surface. Then, when the sewage is discharged onto the bed in freezing weather, as it fills the furrows an ice roof will gradually form spanning them and protect the sides and bottoms of the furrows from freezing, especially if a snowfall occurs before the severe weather sets in. It may sometimes be found necessary with beds that are well underdrained to provide board coverings for the furrows to take the place of the natural ice roofs. After each thaw, when the ice roof has disappeared, the sand in the furrows should be loosened and cleaned. In the spring the surface should be leveled off.

The septic tank system described is, as has been stated, of sufficient capacity to take care of 40 to 50 people, but there is no reason why it can not be constructed in a unit small enough to take care of a single family, if desired. The capacity then could be made such as to equal about a 48-hour average flow of sewage. It is suggested that the tank be of approximately the following dimensions: 5 feet long, 4 feet wide, and 3 feet deep.

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